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Original Article

An Internet-based health management platform may effectively reduce the risk factors of metabolic syndrome among career women

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Abstract

Objectives: The purpose of this study is to target career women with metabolic syndrome (Mets) risk factors and investigate the effectiveness of using a health management platform (HMP) to improve health behavior and reduce Mets risk factors.
Methods: This study adopted the structure of a randomized control trial, and targeted full-time career women aged ≥ 20 years, who possessed Mets risk factors. Intervention was performed via an Internet-based HMP, and changes in health behavior 1.5 months and 3 months after intervention and Mets risk factors 3 months after intervention were analyzed.
Results: A total of 66 career women participated in this study. At 3 months, the HMP group displayed better results than the control group in terms of waist circumference, fasting glucose, and the mean number of Mets components. In terms of the group and time interaction analysis on health behavior, the HMP group only displayed significantly better results in exercise scores than the control group at 1.5 months.
Conclusion: The application of an Internet-based tailored HMP can facilitate an effective improvement in Mets components of career women with Mets risk factors.

Keywords: career women; health management platform; Internet; metabolic syndrome

Introduction

Changes in lifestyle and food culture in modern life have resulted in excessive calorie intake and reduced daily exercise, which has increased the prevalence of obesity, and this is now a worldwide health issue [1,2]. Metabolic syndrome (Mets) presents a cluster of risk components for cardiovascular disease (CVD), including atherogenic dyslipidemia, elevated blood pressure, elevated glucose, a prothrombotic state, and a proinflammatory state [3]. People with Mets are at higher risk of diabetes, coronary heart disease, and mortality due to CVD [4,5]. Asian races are more susceptible to accumulating intra-abdominal fat and developing CVD than Caucasians, even with a lower body mass index [6,7]. In Taiwan, urban women aged 30–39 years have a 5% probability of suffering Mets, and this probability increases to 10% for women aged 40–49 years [8]. Women often perform multiple roles at home and at work, and stress from the conflict of multiple roles can cause women to become prone to the multiple risk factors of CVD, such as hyperlipidemia, hypertension, or diabetes [9].

Work stress is a significant risk factor of Mets. Studies have shown that employees with chronic work stress run twice as much risk of developing Mets than those without stress [10,11]. Factory workers with Mets run a higher risk of developing other diseases. The healthcare costs, pharmacy costs, and short-term disability costs of such employees are

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3.36 times compared to the costs of those without Mets or other diseases. Reducing the risk factors of these high Mets-risk employees can improve their health status, reduce operating costs, and increase productivity [12,13].

In today's modern Internet-mature society, people frequently obtain health information from the web [14]. The Internet possesses tremendous potential for public health education. Medical staff can also provide care services using a combination of the Internet and healthcare. In recent years, telemedicine has also proven to be quite successful in monitoring and tracking various chronic diseases (including diabetes, asthma, heart failure, and hypertension) and weight loss [15–19].

Telemedicine and e-health, which were developed from the Internet and other related technologies, have the same primary objective, namely, to promote healthcare to medically-underserved populations via telecommunication technology [20]. The Internet is a fundamental source of health information. Over the past 10 years, the population of web users seeking health information has increased rapidly [21], with young women being especially active users of Internet-based health information [22]. In Taiwan, while medical services are quite convenient, the types of medical treatment differ from those in western countries. However, few existing studies provide empirical research regarding disease management or health promotion via Internet-based platforms. Therefore, this study focuses on the health management of career women with Mets risk factors. By monitoring risk factors using information technology and investigating the effectiveness of such intervention, it aims to establish an effective self-management system to enhance the self-caring abilities of career women.

Materials and methods

Participants

This study adopts a structure of a randomized control trial to investigate the effectiveness of a health management platform (HMP) intervention measure targeting career women with Mets risk factors. From April to June 2010, posters were displayed in a teaching hospital in northern Taiwan to attract women with Mets risk factors. The criteria for inclusion were: (1) full-time career women aged 20 or more; (2) one or more component(s) of Mets; and (3) able to communicate in Taiwanese or Mandarin. Exclusion criteria were: (1) incapable of using a computer or the Internet on their own; (2) systemic chronic diseases; (3) used weight loss drugs in the past 6 months; (4) recently diagnosed with diabetes or receiving cardiovascular medication; (5) mental illness; and (6) inability to exercise due to joint problems. Prior to the execution of this study, authorization was obtained from the Institutional Review Board of the study hospital, and the related documents were approved. Additionally, written consent forms were also obtained from each participant who agreed to take part in this study.

After agreeing to participate, the women completed a personal information survey with the assistance of experienced research assistants. In terms of their menopausal status, *perimenopause* referred to women who had experienced at least two cycles of irregular menstruation or had ceased menstruating for <1 year; *postmenopause* referred to women with no menstrual periods for ≥ 12 consecutive months. Women were randomly divided into two groups: the HMP group and the control group. The two groups were tested for Mets indicators prior to the study and the participants were instructed to complete questionnaires regarding their health behavior. The HMP group was then provided with manuals describing the HMP, and instructed how to use the content and platform by research staff. Health management intervention using these platforms was performed for a subsequent 1.5 months. The control group did not receive any intervention. At 1.5 months, the two groups were asked to complete a second health behavior questionnaire. After 3 months, a third questionnaire was completed, and a second test for Mets factors was performed. The first and third questionnaires were completed via face-to-face interviews with a research assistant, and the second questionnaire was completed with a direct telephone interview to avoid possible bias.

Components of metabolic syndrome

The definition of Mets in the present study was based on the Mets criteria of the Bureau of Health Promotion in Taiwan [23]. Women who possessed at least three of the following five criteria were diagnosed as having Mets: (1) a waist circumference ≥ 80 cm; (2) systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg; (3) a fasting glucose level ≥ 1.0 g/L; (4) a triglyceride level ≥ 1.5 g/L; and (5) a high-density lipoprotein cholesterol (HDL-C) level < 500 mg/L. The waist circumference was measured to the nearest 0.1 cm at the midway between the lowest margin of the rib cage and the iliac crest. The blood pressure was measured on the right arm of the subject using an automatic blood pressure monitor following a 15-minute rest.

After an overnight fasting period of at least 8 hours, their levels of fasting glucose, total-cholesterol, HDL-C, and triglyceride values were measured using commercial kits and an automated analyzer (Synchron CX9; Beckman Coulter Co., Fullerton, CA, USA) in the hospital laboratory.

Health behavior scale

This study applied an adaptation of a health behavior scale for Taiwanese menopausal women to assess the health behavior of participants [24]. The nutrition and exercise items of the original questionnaire were modified according to the study participants. To ensure expert validity, experts in obstetrics and gynecology, nursing, metabolism, nutrition, and exercise participated in the modification. A pretest was performed on 10 career women, and the final revisions resulted in a health behavioral scale for women. Cronbach's α of the entire scale was 0.807, and Cronbach's α of each item ranged between 0.7 and 0.825, which indicate good internal consistency. The scale comprised four aspects: knowledge of nutrition (10 questions), exercise (4 questions), health responsibilities (3 questions), and mental health (7 questions), comprising a total of 24 questions. A 5-point scoring method was applied, with the scores

designated as follows: 5 for completely accomplished (100% accomplishment), 4 for often accomplished (75% accomplishment), 3 for occasionally accomplished (50% accomplishment), 2 for seldom accomplished (20% accomplishment), and 1 for zero accomplishment. Higher scores denoted a more complete execution of health behavior.

Health management platform

The Internet platform applied in this study was a client-provided health management system (Chien Heng Technologies, Ltd., Taipei, Taiwan) used in the study hospital. The functions used in this study included a health examination database, nutrition management system, and exercise management system. Participants were able to log into the system with individual passwords to check personal test data and upload personal dietary and exercise records. Based on these two records, an approximate calculation of calorie intake and calorie consumption was then automatically calculated by the system. Health management experts also provided nutrition and exercise recommendations and advice according to these records.

Data analysis

The quantitative data of this study was analyzed using SPSS for Windows version 17.0 (Allyn & Bacon, Inc., Needham Heights, MA, USA). The basic information of the subjects underwent a descriptive analysis in terms of percentage, mean value, and standard deviation. The demographic variables of the two groups were subjected to a descriptive analysis using an independent sample t test, Chi-square test, and nonparametric test. Changes in anthropometric and biochemical indicators before and after health management system intervention were analyzed using ANCOVA. Changes in individual health behavior were analyzed via a mixed model. Statistical results with $p < 0.05$ were denoted as being statistically significant.

Results

A total of 66 career women initially participated in this study, with the HMP group and control group containing 33 participants each. During the study process, two women of the

Table 1
Demographic characteristic of the subjects.

Variables	Control group ($N = 31$)		HMP group ($N = 32$)		t	χ^2	p	Fisher
	Mean ± S.D	No. (%)	Mean ± S.D	No. (%)				
Age	41.90 ± 9.80		45.66 ± 8.32		−1.64		0.106	
Education								
High school or below		1 (3.2%)		6 (18.8%)				0.104
College or above		30 (96.8%)		26 (81.2%)				
Work type								
Sedentary		21 (67.7%)		19 (59.4%)		0.473	0.490	
Dynamic		10 (32.3%)		13 (40.6%)				
Personal income (NTD/year)*								
<600,000		16 (55.2%)		23 (74.2%)		2.283	0.123	
>600,000		13 (44.8%)		8 (25.8%)				
Marital status								
Married/cohabitation		18 (58.1%)		22 (68.8%)		0.776	0.378	
Single/Divorced/widowed		13 (41.9%)		10 (31.3%)				
Chronic disease								
No		29 (93.5%)		27 (84.4%)				
Yes		2 (6.5%)		5 (15.6%)				0.426
Smoking								
Yes		0 (0%)		0 (0%)				1.000
No		31 (100%)		32 (100%)				
Drinking								
Yes		1 (3.2%)		0 (0%)				0.492
No		30 (96.8%)		32 (100%)				
Annual health examination								
No		18 (58.1%)		22 (68.8%)		0.776	0.378	
Yes		13 (41.9%)		10 (31.2%)				
Menopause**								
No		20 (64.5%)		22 (68.8%)		0.127	0.722	
Yes		11 (35.5%)		10 (31.2%)				
Family history of chronic disease								
No		8 (25.8%)		7 (21.9%)		0.134	0.714	
Yes		23 (74.2%)		25 (78.1%)				
Diet								
Vegetarian		2 (6.5%)		3 (9.4%)				1.000
Non- Vegetarian		29 (93.5%)		29 (90.6%)				

HMP: Health management platform; *600,000NTD ~20,000 USD; ** menopause was defined as no menstrual periods >12 consecutive months.

Table 2
Baseline parameters of metabolic syndrome and health behavioral scale of HMP group and control group.

Variables	HMP group ($n = 31$)	Control group ($n = 32$)	p
Age	41.9 ± 9.8	45.7 ± 8.3	0.11
Components of Mets			
WC (cm)	91.9 ± 11.0	88.9 ± 10.0	0.26
Systolic BP (mmHg)	127.6 ± 18.5	126.3 ± 18.9	0.78
Diastolic BP (mmHg)	76.5 ± 12.5	73.3 ± 10.2	0.27
Fasting glucose (mg/dl)	110 ± 33.1	99.28 ± 14.7	0.10
TG (mg/dl)	123.2 ± 74.5	117.6 ± 57.2	0.74
HDL-C (mg/dl)	51.1 ± 12.0	44.3 ± 9.7	0.02*
Health Behavioral scale	77.7 ± 13.5	73.1 ± 14.7	0.20
Nutrition	31.5 ± 6.1	28.6 ± 6.3	0.07
Exercise	11.7 ± 3.3	11.0 ± 3.1	0.39
Health responsibility	8.9 ± 2.7	9.1 ± 2.6	0.85
Mental health	25.6 ± 4.8	24.5 ± 5.3	0.39

HMP: Health management platform; Mets: metabolic syndrome; WC: waist circumference; BP: blood pressure; TG: triglyceride; HDL-C: high density lipoprotein cholesterol; *$p < 0.05$.

HMP group and one woman of the control group left the study (for personal reasons). This resulted in 31 participants in the HMP group, 32 participants in the control group, and 63 participants in total, with a 4.55% loss rate.

The mean ± standard deviation age was 41.9 ± 9.8 years for the HMP group and 45.7 ± 8.3 years for the control group. Table 1 lists the basic information of the subjects, including their socio-economic status, past medical history, smoking habits, annual health examinations, menopausal status, chronic disease history, and dietary patterns. No significant differences were found between the two groups.

Table 2 compares the Mets and health behavior indicators at the beginning of the study. Apart from a lower serum HDL-C concentration in the control group when compared with that of the HMP group, no other significant differences were exhibited between the two groups.

Table 3 displays the Mets indicator test results of the two groups at the beginning of the study and the end of 3 months. The HMP group showed significantly better results in the change of waist circumference (−3.5 vs. 0.6 cm, $p < 0.05$), fasting glucose (−6.5 vs. 3.1, $p < 0.05$), and the mean number of Mets components (−0.6 vs. +0.1 , $p < 0.05$) when compared to the control group.

Fig. 1 illustrates changes in health behavior throughout the study. Table 4 lists the mixed model analysis results of health behavioral changes. The results in Fig. 1 demonstrate that the health behavioral scores of both groups increased, and the mixed model analysis results reveal significant differences in the nutrition scores of the two groups ($p = 0.03$). In terms of the time effect, the nutrition scores at 1.5 months displayed significant time effects, and at 3 months, the total health behavioral scores ($p = 0.02$), nutrition scores ($p = 0.02$), and mental health scores ($p = 0.03$) also displayed significant time effects. All of these three scores increased significantly with time in both groups. In terms of the group and time interaction analysis, only exercise scores at 1.5 months showed significant differences between the two groups. The HMP group had a better group and time interaction effect than the control group on the exercise scores.

Discussion

This study targeted a rare subject by investigating the effectiveness of an Internet-based HMP in improving Mets risk factors. The results demonstrated that using the HMP together with a health management expert enables immediate and frequent feedback to be provided to career women with Mets, which subsequently helps to improve the Mets risk factors. Although only exercise displayed a group and time interaction effect regarding health behavior in the short-term, waist circumference, fasting glucose level, and frequency of Mets were effectively improved in the HMP group. These results indicate that the HMP system is a valuable and feasible application.

Although most previous studies have revealed that e-health interventions were superior in a comparison group on physical activity and dietary behavioral change [25–28], other studies have failed to demonstrate such a positive effect [29,30]. Some studies have indicated that using Internet-based tailored health intervention for personal health needs is helpful for targeting personal health behavior [31,32]. This study applied a mixed model to analyze the health behavior of the HMP and control groups, and exhibited a significant time and group interaction effect on exercise scores in the short-term. However, such effects subsequently lessened, indicating the

Table 3
Effects of health management platform on anthropometric indices, blood pressure and biochemical profile.

Variables	HMP group		Control group		β	p*
	Pretest	3 Months	Pretest	3 Months		
Body weight (Kg)	69.4 ± 16.0	67.0 ± 15.1	66.4 ± 11.3	65.2 ± 0.5	−1.1	0.099
Waist circumference (cm)	91.9 ± 11.0	88.4 ± 11.2	88.9 ± 10.0	88.3 ± 10.4	−2.6	0.046
Systolic-BP (mmHg)	127.6 ± 18.5	119.9 ± 15.9	126.3 ± 18.9	121.6 ± 14.6	−2.5	0.329
Diastolic-BP (mmHg)	76.5 ± 12.5	73.6 ± 10.1	73.3 ± 10.2	73.5 ± 9.9	−1.5	0.489
Fasting glucose (mg/dl)	110.0 ± 33.1	103.5 ± 22.9	99.3 ± 14.7	102.4 ± 15.7	−5.9	0.040
Triglyceride (mg/dl)	123.2 ± 74.5	123.7 ± 77.0	117.6 ± 57.2	136.4 ± 87.4	−16.1	0.381
HDL-L (mg/dl)	51.1 ± 12.0	47.7 ± 10.3	44.3 ± 9.7	43.9 ± 7.6	−0.5	0.753
Mets No	2.9 ± 1.1	2.3 ± 1.2	2.7 ± 0.9	2.8 ± 1.0	−0.6	0.009

HMP: Health management platform; BP: blood pressure; HDL-C: high density lipoprotein cholesterol; Mets No: number of metabolic syndrome components; *: adjusted; Variables were compared with general liner model.

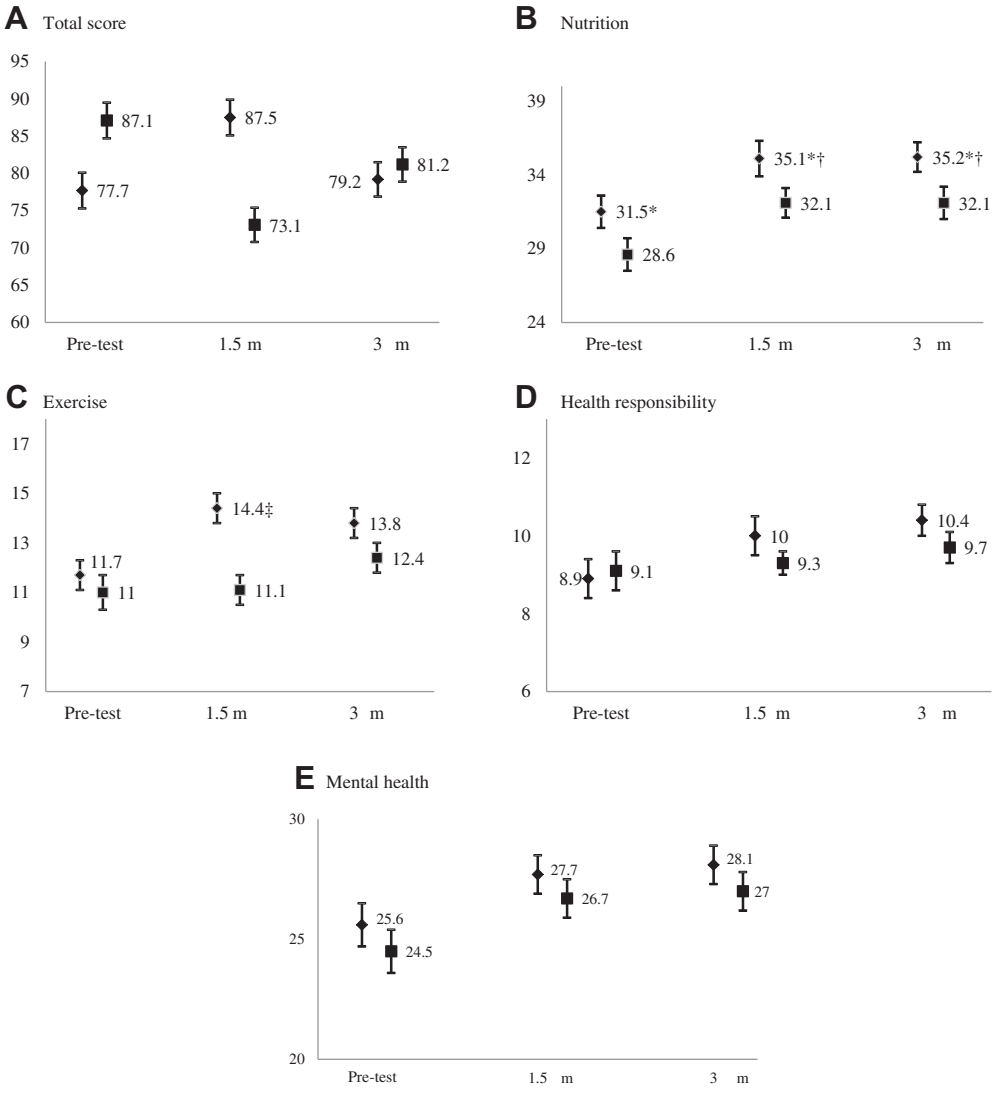

Fig. 1. Effects of health management platform on health behavioral score pretest, and after 1.5 months and 3 months. The error bars represent 95% confidence intervals. Solid diamond: health management platform (HMP) group; Solid square: control group. *: Significant time effect between HMP and control groups ($p < 0.05$); †: Significant time effect ($p < 0.05$); ‡: Significant group × time effect ($p < 0.05$).

importance of continuous intervention. It is difficult to compare the results of the present study with those of previous studies due to different population sizes, intervention methods, scoring methods, and intervention periods. Some techniques were used in the present study to enhance the women's adherence to the applied system. For example, participants could upload dietary and exercise records using the Internet; calorie intake/consumption could be automatically

Table 4
Mixed model analysis on the effects of health management platform on health behavioral score.

	Total score		Nutrition		Exercise		Health responsibility		Mental health	
	β	*p*	β	*p*	β	*p*	β	*p*	β	*p*
Group										
HMP vs Control	6.02	0.09	3.46	0.03*	1.09	0.18	1.33	0.30	0.15	0.82
Time										
1.5 m vs Pre-test	6.09	0.61	3.47	0.02*	0.16	0.84	2.22	0.05	0.25	0.67
3 m vs Pre-test	8.03	0.02*	3.50	0.02*	1.41	0.09	2.53	0.03*	0.59	0.31
Group * Time										
1.5 m vs Pre-test	3.31	0.47	0.13	1.00	2.55	0.03*	−0.16	0.92	0.79	0.35
3 m vs Pre-test	1.78	0.70	0.24	0.90	0.76	0.52	−0.04	0.98	0.83	0.32

*$p < 0.05$; HMP: Health management platform.

calculated by the system; and health management experts could provide advice based on dieting and exercising habits, rather than providing a standard recipe for all, which increased participant compliance. The website also provided various information regarding Mets-related conditions and related health promotion knowledge, which participants could download at their convenience. In addition, health management experts also expressed encouragement or provided advice based on each woman's condition. This system facilitated a high completion rate.

The results of this study also indicated that health behavioral scores displayed significant time effects in both the HMP and control groups. Health behavior could be improved by distributing health education leaflets, magazines, or health information. These results correspond to those from other studies [33,34]. Having participated in the study, women in the control group may have gained an interest in health issues and actively obtained related information from other media; thus, the health behavioral scores of this group were also improved.

Although there are numerous studies on the effect of Internet-based health intervention for nutrition and physical activity, very few have reported the effect of such interventions on clinical prognoses [35–38]. The present study discovered that, although the experimental group only displayed superior exercise scores for a short period of time, changes in their Mets risk factors were significantly superior to those of the comparison group. These results indicated that a mere change in health behavior could significantly reduce the risk of Mets.

The limitations of this study included a relatively small population, which may result in population bias. Also, the period of intervention and follow-up was relatively short. A larger study group, as well as longer study period, are necessary to obtain further conclusions. Additionally, during the course of the study, information obtained from the Internet or other media was not prohibited. However, obtaining health information from media other than the HMP would not affect the results and conclusion, because the Internet has now become an essential part of modern life.

In summary, the Internet-based tailored HMP proposed by this study effectively promotes the improvement of health behavior in career women with Mets risk factors. Compared to the control group, the number of Mets components reduced, and the subjects' waist circumference and fasting glucose improved. Thus, an Internet-based tailored HMP can serve as an ideal tool for health management for career women possessing Mets risk factors.

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